etching away the core material layer using the first portion of the first mask layer as a mask such that a first core material portion remains below the first portion of the first mask layer;

removing the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding material layer so as to cover a surface of the resultant structure;

patterning a second mask layer over the upper cladding material layer, wherein the second mask layer extends across the core material layer and has an end which is aligned with and at least partially overlaps the second portion of the first mask layer;

etching away the upper cladding material layer using the second mask layer as a mask to expose a part of the second portion of the first mask layer; and

etching away portions of the substrate using the exposed part of the second portion of the first mask layer as a mask.

REMARKS

Claims 1-31 are pending in the application, with claim 31 newly presented by the above amendments. Claims 1-30 stand rejected.

The Examiner has objected to the drawings which have been corrected by the above amendments. Applicant respectfully requests that the Examiner approve and enter the drawing amendments.

Claims 6, 12, 19, and 25 have been amended to effect non-narrowing, cosmetic grammatical revisions. Claims 6, 12, 19, and 25 have also been amended to recite that the second mask layer has an end which at least partially overlaps the second portions of the first mask layer. Claim 13 has been amended to correct its dependency, which amendment bears no more than a tangential relation to the subject matter recited in claim 13. Claim1 has been amended recite additional features of Applicant's invention. Claim 31 has been added to claim additional aspects of the invention.

REJECTIONS UNDER 35 U.S.C. 102

The Examiner has rejected claims 1-5 under 35 U.S.C. 102(b) as being anticipated by U.S. 5,784,509 to Yamane et al. Applicant has amended independent claim 1 to recite the feature of "depositing a second mask layer over the at least one integrated optical waveguide core, the second mask layer having an end that is aligned with and at least partially overlaps a portion of the first mask layer". As the Examiner recognized at page 4, second sentence of penultimate paragraph, Yamane "does not teach forming an etch-mask ...that extends over the first etch-mask." Thus, Yamane does not disclose at least the newly added feature of "a second mask having an end that ... at least partially overlaps a portion of the first mask layer." Accordingly, a rejection under 35 U.S.C. 102 cannot stand, and Applicant respectfully requests that the Examiner withdraw the rejections to claim 1 as well as claims 2-5, which depend therefrom.

REJECTIONS UNDER 35 U.S.C. 103

The Examiner has rejected claims 6-30 under 35 U.S.C. 103 as being unpatentable over Yamane in view of U.S. 5,384,872 to Jacobs-Cook et al. and further in view of U.S. 5,961,683 to Mizuta et al.

Applicant's invention as recited in independent claims 6, 12, 19, and 25 relates to a method for fabricating an optical device by providing material layers over a substrate, masking the layers/substrate, and etching the layers/substrate in a specified manner. For example, each of claims 6, 12, 19, and 25 recite a step of providing a mask that at least partially overlaps a previously applied mask layer. In particular, claims 6 and 12 recite the step of "patterning a second mask layer over the upper cladding material layer, wherein the second mask layer extends across the lower cladding material layer and has an end which is aligned with *and at least partially overlaps* the second portion of the first mask layer". (Emphasis Added.) Claim 19 recites the step of "patterning a third mask layer over the upper cladding material layer, wherein the third mask layer extends across the lower cladding material layer and has an end which is aligned with *and at least partially overlaps* the second portion of the first mask layer". (Emphasis Added.) Likewise, claim 25 recites the step of "patterning a second mask layer over the upper cladding material layer, wherein the second

mask layer extends across the core material layer and has an end which is aligned with *and at least partially overlaps* the second portion of the first mask layer."(Emphasis Added.) In contrast, Yamane, Jacobs-Cook, and Mizuta fail to suggest or disclose, singly or in combination, Applicant's claimed feature of a mask having "an end which is aligned with and at least partially overlaps the second portion of the first mask layer", as recited in independent claims 6, 12, 19, and 25.

For example, as the Examiner states, "Yamane's mask layer 36 (fig.39) stops at the edge of the core pattern..." (page five, third paragraph, fourth line of official action.) Thus, Yamane fails to disclose Applicant's claimed feature of mask end overlap. Instead, the Examiner cites Mizuta for the structure of a mask edge extending over the micromachined area. However, Applicant respectfully disagrees with the Examiner's interpretation of Mizuta, where the Examiner states that "the etch-mask 5 (fig.2C) extends over the micromachined structure area." (page five, third paragraph, seventh line of official action.)

As seen in Figs. 2D and 2E of Mizuta, the mask 5 does not extend over the groove-sculpturing area 10 ("micromachined structure area") along which the groove 9 is formed. Indeed, as specifically recited in the text of Mizuta, "[a]s illustrated in FIG. 2C, the end face forming mask 5 covers an upper surface of the optical waveguide layer 4 in an area desired to be left while a remaining area is left uncovered. The remaining area corresponds to a position where a V-shaped groove or a groove 9 (FIG. 2E) is to be formed in the silicon substrate ..."(column 5, lines 29-33. Emphasis Added.) Thus, Mizuta does not disclose or suggest Applicant's claimed feature of a mask having "an end which is aligned with and at leaset partially overlaps the second portion of the first mask layer" as recited in each of independent claims 6, 12, 19, and 25. Likewise, Jacobs-Cook does not disclose or suggest Applicant's claimed feature of a mask having "an end which is aligned with and at least partially overlaps the second portion of the first mask layer".

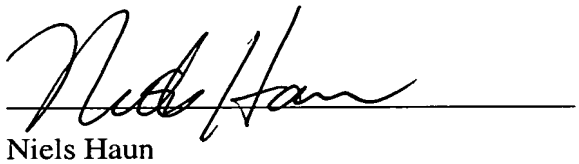
In addition, with regard to claim 19, the proposed combination of Yamane, Mizuta, and Jacobs-Cook fails to disclose or suggest the recited step of "patterning a second mask layer having an opening aligned over the lower cladding material layer." Further, the combination fails to disclose or suggest the recited steps of "etching away the core material layer using the second mask layer and the first portion of the first mask layer as masks,

wherein a first portion of the first core material layer remains below the first portion of the first mask layer, and a second portion of the first mask layer remains below the second mask layer; removing the second mask layer and the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding layer so as to cover a surface of the resultant structure".

Hence, for the above reasons, the proposed combination of Yamane, Mizuta, and Jacobs-Cook fails to disclose or suggest each and every element of Applicant's invention as recited in independent claims 6, 12, 19, and 25. Accordingly, for at least this reason, Applicant respectfully requests that the Examiner withdraw the rejection of claims 6, 12, 19, and 25, as well as, claims 7-11, 13-18, 20-24, and 26-30 which depend, respectively, therefrom.

In view of the foregoing amendments and remarks, it is believed that the claims in this application are now in condition for allowance. Early and favorable reconsideration is respectfully requested. The Examiner is invited to telephone the undersigned in the event that a telephone interview will advance prosecution of this application.

Respectfully submitted,



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ATTACHMENT

The following are the marked up copies of the specification as amended. Bracketed text has been deleted, and underlined text has been inserted.

1. Copy of paragraph [0150] marked up to show amendments.

[0150] The structure of FIG. 1(i) is then subjected to a wet etch to obtain the structure of FIG. 1(j) in which inclined surface features 109 are formed at opposite sides of the silicon substrate 101. Note that the inclined surface features 109 are defined here by the same mask pattern [what] that was previously used to define[d] the waveguide portions 105a of the core material layer. Also note that the inclined surface features 109 may actually define half of a V-shaped groove in the case where another device is being simultaneously formed in the substrate 101 adjacent to the device illustrated in the drawings.

2. Copy of paragraph [0165] marked up to show amendments.

[0165] Another illustrative embodiment of the present invention will now be described with reference to the top views of FIGs. 2(a) through 2(i) and the side views of FIG. 3(a) through 3([n]m). Throughout these figures, like elements are designated by the same reference numbers. In this embodiment, a generally V-shaped groove (micro-machined feature) is aligned with an integrated optical waveguide core(s).

3. Copy of paragraph [0220] marked up to show amendments.

[0220] Turning to FIG. 7(b), a mask 790 is formed over the core material layer 705 and the mask pattern 706a[/706b] so as to have an opening aligned with the lower cladding layer 704. The exposed portions of the core material layer 705 are then removed by RIE and the mask 790 is removed to obtain the structure depicted in FIG. 7(c). Here, reference number 705b denotes the waveguide portions of the core material layer remaining after etching.

4. Copy of paragraph [0225] marked up to show amendments.

[0225] The portions 706b of the first mask are then removed, and an upper cladding layer 707 is deposited as shown in FIG. 7(d). A mask 710 is applied over the upper cladding layer 707 as shown in FIG. 7(e) and this [This] structure is then subjected to an etch process (e.g., wet etching or RIE) to remove portions of the upper cladding layer 707 [and] not covered by the mask 710 to thereby define the machined features as shown in FIG. 7(e). The process then proceeds as in the first described embodiment (see FIG. 1 (i)). One advantage of the present embodiment is that the machined features can be more accurate since the core layer defining the machined features is etched only once.

5. Copy of paragraph [0245] marked up to show amendments.

[0245] Turning to FIG. 8(c), a core material layer 805 is deposited over the surface of the cladding material layer 804. In this embodiment, the core material layer [105] 805 is formed of silica. However, other materials may be used, including but not limited to silicon and silicon nitride. The structure of FIG. 8(c) is then planarized to obtain the structure of FIG. 8(d). As shown, both the core material layer 805 and the cladding layer material 804 are contained within the pit 802, and the remaining surface of the substrate 801 is exposed.

6. Copy of paragraph [0260] marked up to show amendments.

[0260] Turning to FIG. 8(h), a mask 808 is deposited over the cladding material layer 807 so as to cover the waveguide portions 805b and partially overlap the mask layer portions 806a [and underlying etched feature portions 805a]. Another etch process (e.g., wet etching or RIE) is then performed down to the silicon substrate 801 to obtain the structure illustrated in FIG. 8(i). As shown, the mask layer portions 806a remain on the surface of the silicon substrate 801.

7. Copy of paragraph [0275] marked up to show amendments.

[0275] As with the previous[ly] embodiments, the horizontal distance between the waveguide cores 805a and the inclined surface feature 809 is precisely set since the same mask pattern

[106a/106b] 806a/806b is used to etch both the waveguide 805a and the feature 809, and the device characteristics and alignment tolerances are thereby improved.

The following are the marked up copies of the claims as amended. Bracketed text has been deleted, and underlined text has been inserted.

1. (Amended Once) A method of fabricating an optical device having at least one integrated waveguide and at least one micro-machined feature, comprising:

depositing a first mask layer over a surface of a substrate structure, and patterning the first mask layer to obtain a mask pattern over the surface of the substrate structure; [and]

conducting a first etching process for obtaining the at least one integrated optical waveguide core at the surface of the substrate structure;

depositing a second mask layer over the at least one integrated optical waveguide core, the second mask layer having an edge that is aligned with and at least partially overlaps a portion of the first mask layer; [,] and

conducting a second etching process for obtaining the at least one micro-machined feature at the surface of the substrate structure, wherein the first mask pattern is used as a mask in both the first and second etching processes.

6. (Amended Once) A method of fabricating an optical device, comprising:

forming a lower cladding material layer within a recess of a substrate;

forming a core material layer over the lower cladding material layer and a surface of the substrate;

patterning a first mask layer over the core material layer, wherein the first mask layer is patterned such that a first portion [is] extends over the lower cladding material layer, and such that a second portion extends over the surface of the substrate adjacent to the lower cladding material layer;

etching away the core material layer using the first mask layer as a mask such that a first core material portion remains below the first portion of the first mask

layer and a second core material portion remains below the second portion of the first mask layer;

removing the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding material layer so as to cover a surface of the resultant structure;

patterning a second mask layer over the upper cladding material layer, wherein the second mask layer extends across the lower cladding material layer and has an end which is aligned with and at least partially overlaps the second portion[s] of the first mask layer;

etching away the upper cladding material layer using the second mask layer as a mask to expose a part of the second portion of the first mask layer; and

etching away portions of the substrate using the exposed part of the second portion of the first mask layer as a mask.

12. (Amended Once) A method of fabricating an optical device, comprising:

forming a lower cladding material layer within a recess of a substrate;

forming a core material layer over the lower cladding material layer and a surface of the substrate;

patterning a first mask layer over the core material layer, wherein the first mask layer is patterned such that a first portion [is] extends lengthwise over the lower cladding material layer, and such that a second portion extends over the substrate surface adjacent to the lower cladding material layer and defines an elongate opening which is aligned in a lengthwise direction with the first portion of the first mask layer;

etching away the core material layer using the first mask layer as a mask such that a first core material portion remains below the first portion of the first mask layer and a second core material portion remains below the second portion of the first mask layer;

removing the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding material layer so as to cover a surface of the resultant structure;

patterning a second mask layer over the upper cladding material layer, wherein the second mask layer extends across the lower cladding material layer and has an end which is aligned with and at least partially overlaps the second portion of the first mask layer;

etching away the upper cladding material layer using the second mask layer as a mask to expose a part of the second portion of the first mask layer; and

etching away portions of the substrate using the exposed part of the second portion of the first mask layer as a mask.

13. (Amended Once) The method as claimed in claim [13] 12, wherein the first mask layer is planar.

19. (Amended Once) A method of fabricating an optical device, comprising:

forming a lower cladding material layer within a recess of a substrate;

forming a core material layer over the lower cladding material layer and a surface of the substrate;

patterning a first mask layer over the core material layer, wherein the first mask layer is patterned such that a first portion [is] extends over the lower cladding material layer, and such that a second portion extends over the substrate surface adjacent to the lower cladding material layer;

patterning a second mask layer having an opening aligned over the lower cladding material layer;

etching away the core material layer using the second mask layer and the first portion of the first mask layer as masks, wherein a first portion of the first core material layer remains below the first portion of the first mask layer, and a second portion of the first mask layer remains below the second mask layer;

removing the second mask layer and the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding layer so as to cover a surface of the resultant structure;

patterning a third mask layer over the upper cladding material layer, wherein the third mask layer extends across the lower cladding material layer and has an end which is aligned with and at least partially overlaps the second portion[s] of the first mask layer;

etching away the upper cladding material layer using the third mask layer as a mask to expose a part of the second portion of the first mask layer; and

etching away portions of the substrate using the exposed part of the second portion of the first mask layer as a mask.

25. (Amended Once) A method of fabricating an optical device, comprising:

forming a lower cladding material layer within a recess of a substrate such that an upper surface of the lower cladding material layer is below a surface of the substrate;

forming a core material layer within the recess and over the lower cladding material layer;

patterning a first mask layer over the core material layer and a surface of the substrate, wherein the first mask layer is patterned such that a first portion extends over the core material layer, and such that a second portion extends over the surface of the substrate surface adjacent to the core material layer;

etching away the core material layer using the first portion of the first mask layer as a mask such that a first core material portion remains below the first portion of the first mask layer;

removing the first portion of the first mask layer to obtain a resultant structure and depositing an upper cladding material layer so as to cover a surface of the resultant structure;

patterning a second mask layer over the upper cladding material layer, wherein the second mask layer extends across the core material layer and has an end which

is aligned with and at least partially overlaps the second portion[s] of the first mask layer;

etching away the upper cladding material layer using the second mask layer as a mask to expose a part of the second portion of the first mask layer; and

etching away portions of the substrate using the exposed part of the second portion of the first mask layer as a mask.